AERMOD Training

I. Introduction to Understanding the AERMOD System

The TCEQ is intent on streamlining the process of pre-processing the meteorological data. To understand the issues involved in preprocessing, we will examine the data requirements for AERMET.

A. It is critically important to understand the three new surface characteristics that are required by the AERMET preprocessor. The staff of the TCEQ has some ideas that we would like to put forward for comments from you.

B. The goals today are to understand the key surface characteristics used by the AERMET preprocessor.

C. First, it is important to remind some people that Texas is a BIG state! While some states may only have one or two meteorological stations to examine for modeling, Texas has 17 surface stations and 9 upper air stations. We need to have a manageable, reasonable approach to modeling.

D. Texas has a wide variety of climate and surface characteristics. Many times, a smaller state does not have to address such a diversity of climate and surface characteristics.

II. Albedo

A. The definition of albedo is:

"The albedo is the fraction of total incident solar radiation reflected by the surface. Typical values range from 0.1 for thick deciduous forests to 0.90 for fresh snow."

B. Within the modeling domains, there is a wide range of albedo values. There will be bright areas and dark areas. That may involve some white concrete surfaces and some dark asphalt surfaces. There may be some light colored crops and some dark colored trees.

From our modeling point of view, the higher the albedo, the more reflection of incoming solar radiation occurs. The more reflection of incoming solar radiation that occurs, the less energy is available for sensible heat to be lost from our surface. The less sensible heat that is lost from our surface, the less convective turbulence there will be.

C. Remember albedo values by:

"BIG AND BRIGHT" -- A big albedo value is a bright surface.

D. AERMET requires an average noontime albedo. Albedo is not used for nighttime hours.

E. Typically, the modeling domain's surface characteristics are not homogeneous.

Therefore, why "pretend" like an exact value for albedo can be determined?

F. There are known relationships between albedo and general vegetation coverage. If one could use those relationships to determine general albedo values for areas, then one could assign albedo to county-wide areas for modeling purposes.

G. Matthews' (NASA) relationships were used to obtain average noontime albedo values from typical vegetation coverage in Texas. The resulting albedo map of Texas appears to be a reasonable approximation of the characteristic albedo values across the state.

H. Albedo - Just keep it simple!

III. Bowen Ratio

A. The Bowen ratio is the ratio of the sensible heat flux (H) to the latent (evaporative) heat flux (E).

Bowen Ratio = H/E

B. Remember:

"High and Dry" – A high Bowen Ratio is generally a dry surface.

C. AERMET requires an average mid-day Bowen Ratio for calculations related to daytime convective conditions. Bowen Ratio is not used for nighttime hours. As with albedo, if a source's maximum occurs at night, then Bowen Ratio will have no effect on the predicted concentration.

D. Fortunately, in Texas, Bowen Ratios have already been determined based on water models that include rainfall, surface runoff, and other factors. The reference for this study is: "Spatial Water Balance of Texas", Seann M. Reed, et al, Center for Research in Water Resources, University of Texas at Austin.

E. A map of average Bowen Ratio in Texas illustrates the variations in Bowen Ratio.

The darker areas represent the greater Bowen Ratios. One can observe that West Texas has the greatest Bowen Ratios in the State.

F. Bowen Ratio - Just keep it simple!

IV. Roughness Parameter

A. Definition from the AERMET User's Guide:

"The surface roughness length is related to the height of obstacles to the wind flow and is, in principle, the height at which the mean horizontal wind speed is zero. Values range from less than 0.001 meter over a calm water surface to 1 meter or more over a forest or urban area."

B. How can one develop a method to determine roughness that will provide a reasonable representation (model) of the area being modeled? Can the method used provide some consistency in the modeling or will every model run need uniquely pre-processed meteorological data?

C. The concept for choosing a roughness parameter is simplicity, reproducibility, and reasonableness. Remember, ISC3 essentially used only two roughness lengths. The urban and rural roughness lengths.

For "General" modeling, the preferred method will be to choose one of three roughness lengths for modeling. The choice will be based on a review of the modeling domain taking into account the source characteristics. Justification of this choice will need to be documented in the modeling report.

For "Special Case" modeling, the method will be to carefully analyze the surface characteristics. In situations where the surrounding area may have variations in land use, use eight sectors to define the roughness lengths. Examine each sector to a distance of the modeling domain which is dependant upon source characteristics. Choose a roughness length that best fits the land use within each sector.

D. The TCEQ has compiled published roughness parameter data from 20 studies. Over 140 values for roughness length have been tabulated.

E. The published data illustrates the range of roughness values that one must deal with. One must survey the region of the modeling domain. It is important to not think in terms of just a 3 kilometer radius anymore. The modeling domain is dependant upon source characteristics.

After surveying the domain for roughness, what information do you have? It will almost always be a mix of many different roughness values. A general roughness

value for the modeling domain may be chosen from one of three categories of roughness: Low, medium, and high roughness.

F. Next, it is important to stop for a reality check.

How well can one really "calculate", "estimate", or "guess" at the roughness parameter for the modeling domain? How homogeneous is the modeling domain? Can one document it sufficiently for submittal and review to the TCEQ? Is it not true that a 3-category method would work as well?

G. Keep it Simple!

Consider using one of three categories for roughness and document your choice.

Category 1: Flat Areas
0.001 – 0.1 m ----> Use a value of 0.05 m

Category 2: Rural/Suburban Areas
0.1 – 1.0 m ----> Use a value of 0.5 m

Category 3: Urban/Industrial Areas
0.7 – 1.5 m ----> Use a value of 1.0 m

H. Photographic examples of roughness categories may be used to help permit applicants and consultants correctly determine roughness categories for modeling purposes.

V. Summary

The TCEQ's implementation of AERMOD is based on the following:

Reasonable approach
Consistent approach
Equitable/Fair approach
Reviewable approach

One needs a reasonable approach to processing meteorological data in the great state of Texas. It must be consistent, which lead to fair treatment for everyone. And it must be a reviewable approach. A method that the TCEQ can review, audit, and reproduce.